B. P. I.—692.

Issued August 7, 1911.
No. "A"—77.

United States Department of Agriculture,

BUREAU OF PLANT INDUSTRY,

Farmers' Cooperative Demonstration Work,

WASHINGTON, D. C.

FARM FERTILIZERS.[1]

No farming people have ever been able economically to maintain the fertility of their soils without the use of live stock. Farming without the use of manures is a waste of energy and results in the exhaustion of soils. The neglect in preserving and increasing the quantity of farm manures has been a great drain on the natural resources of the American farm, especially in the southern portion of the United States. The lack of intelligent care of the waste products and the convenient form of commercial fertilizers have jointly been responsible for the almost general neglect of farm manures.

Commercial fertilizers have played and will continue to play a great part in the farm economy of the country. Their full value, however, can not be obtained by their exclusive use. A much greater value can be had from them when used wisely in connection with manure and green crops. One of the principal reasons for the small value sometimes realized from manure of any kind is that it has not been properly handled and through exposure and neglect has lost a large percentage of its plant food. The chief difference between barnyard manure and other vegetable matter is that the process of passing through the animal has rendered the fertilizing elements of the former more available for absorption in plant growth. The best authorities tell us that from 75 to 90 per cent of the fertilizing value of a crop is left after passing through the animal. This being true and the elements being in a soluble form, we have some idea of why it is of the utmost importance to protect the manure supply from

[1] A circular having the same title, formerly issued as No. "A"—72, was prepared by the late Dr. S. A. Knapp. This has been revised and rewritten by W. B. Mercier and H. E. Savely, of the Office of Farmers' Cooperative Demonstration Work. It is of elementary character and especially designed for the guidance of southern farmers.

leaching by rains or from other sources of loss. The Cornell University Experiment Station[1] found that as much as 50 per cent of the plant-food constituents in manure was lost by leaching and unnecessary fermentation. The problem is how best and most economically to prevent this loss. The best plan where it is practicable is to haul out the manure regularly, spread it upon the land, and plow it under. The best results are usually obtained by turning under shallow. The next best plan is to keep the stock under sheds or in stables with sufficient litter to absorb all liquids. This treatment will not only take up moisture but the continual trampling of the animal will exclude all air, so that the accumulation may go on without injury to its quality until a convenient time to remove and spread it on the land. The litter or waste matter used for bedding not only serves its purpose in helping to preserve the manure, but adds considerably to it.

When neither of these plans can be advantageously used, a cheap shed conveniently located may be substituted and all manure carried to it as removed. Care must be taken to prevent heating, which is especially liable to happen when horse manure predominates. This can be remedied by adding water when needed.

While the farmer may buy plant food in the form of commercial fertilizer, it will not have so beneficial an effect on the crops as an equal amount contained in barnyard manure. It does not add vegetable matter, does not promote bacterial activity, and does not correct mechanical defects of the soil. A ton of well-preserved manure from a well-fed horse contains about 9.8 pounds of nitrogen, 5.2 pounds of phosphoric acid, and 9.6 pounds of potash. Assuming a value of 20 cents a pound for nitrogen and 5 cents a pound each for phosphoric acid and potash,[2] this plant food would cost $2.70 if bought in the form of commercial fertilizer.

QUANTITY OF MANURE PRODUCED BY STOCK.

It has been estimated that the various classes of farm animals will produce about the following quantities of solid and liquid manure during a year:

TABLE I.—*Quantities of manure produced in a year by farm animals.*[3]

Animal.	Solid.	Liquid.
	Pounds.	*Pounds.*
Horse	12,000	3,000
Cow	20,000	8,000
Sheep	760	380
Pig	1,800	1,200

[1] Watson, George C. The Production of Manure. Bulletin 56, Cornell University Agricultural Experiment Station.

[2] These prices are used throughout this circular.

[3] From Fletcher, S.W., "Soils."

By keeping stables of horses and cows well bedded with litter the above showing can be greatly increased.

TABLE II.—*Composition, amount, and value of manure produced by different kinds of farm animals.*[1]

	Analysis (pounds per ton).				Value per ton.	Amount and value per 1,000 pounds live weight per day and year.		
	Water.	Nitrogen.	Phosphoric acid.	Potash.		Pounds per day.	Value per day.	Value per year.
Horse	913.8	9.8	5.2	9.6	$2.70	48.8	$0.0658	$25.00
Cow	1,505.0	8.6	5.8	8.8	2.45	74.1	.0845	32.30
Sheep	1,190.4	15.4	7.8	11.8	4.06	34.1	.0693	25.29
Pig	1,482.6	16.8	7.8	6.4	4.07	83.6	.1701	62.05

While the actual plant food contained in a ton of well-preserved barnyard manure is worth at least $2.50, it is safe to say that the farmer will derive nearer $4 worth of good from it. Barnyard manure not only furnishes plant food but greatly improves the mechanical condition of the soil and multiplies beneficial bacteria.

Farm manure should be handled with great care. It should never be left in the open yard or piled in the field for any length of time, as much of its plant food will be leached out. Neither should it be stored loose under sheds, but it should be packed down and kept wet enough to prevent heating, which would drive off nitrogen. This tremendous loss from improper handling easily explains why farmers find it necesary to use such large quantities of manure to derive much benefit from it. It will be observed that even when manure is stored in a shed there is loss. By covering the manure heap with certain substances it is found that not only can this loss be prevented, but the stock of manure can be very greatly increased. A ton of ordinary loam will absorb about 13 pounds of nitrogen, and if placed over the manure heap will prevent all loss of that substance. Sawdust will absorb 8 pounds per ton. Wheat straw will absorb nearly 4 pounds of nitrogen.

The materials named in Table III are more or less available on every farm.

[1] Watson, George C. Loc. cit.

TABLE III.—*Amounts of nitrogen, phosphoric acid, and potash contained in a ton of different bedding materials.**

Kind of straw or litter.	Analysis (pounds per ton).			Fertilizing value per ton.
	Nitrogen.	Phosphoric acid.	Potash.	
Wheat straw	9.6	4.4	16.4	$2.96
Rye straw	11.2	5.1	18.1	3.40
Oat straw	14.4	3.6	23.0	4.19
Barley straw	11.4	5.0	23.5	3.70
Pea straw	20.8	7.0	19.8	5.32
Soy-bean straw	14.0	5.0	22.0	4.15
Buckwheat straw	13.0	7.1	24.2	4.15
Millet straw	14.0	3.6	34.0	4.68
Marsh hay	17.2	10.6	54.0	6.47
Leaves	15.0	3.2	6.0	3.46
Rice straw	15.1	5.2	8.4	3.70

* This table is taken principally from William P. Brooks's "Agriculture," vol. 2.

VALUE OF PLANT FOOD TAKEN FROM THE SOIL BY DIFFERENT CROPS.

Every ton of cowpea hay taken from the farm, the manure of which is not returned to the soil, robs it of $7.96 worth of fertilizer; a ton of cotton seed, $18.80; an acre of corn producing 50 bushels, both stalk and grain, $18.56. The grain alone contains $9.36 worth of fertilizer. An acre of oats producing 35 bushels removes in the entire crop $11.33 worth of fertilizer, and $4.72 for the grain alone.[1]

This has been going on until the farm responds reluctantly to the many drafts made upon it. It will be seen that the farmer must manage to restore this fertility. No better method of doing this can be found than to keep enough stock on the farm to consume all the grain and forage produced. The stock should be kept under sheds and in stables when possible, and an abundance of bedding furnished to absorb the liquids as well as to add to the bulk of the manure heap.

The roots and stubble of crops always restore something to the soil. With such crops as clover, cowpeas, or beans, approximately 30 per cent of the manurial value of the crop is kept in the soil. When such crops are harvested for hay and fed to good farm stock and the manure is returned to the land, 80 to 90 per cent of the entire fertilizing value is kept on the farm. At the same time the full feeding value is obtained; hence, we can just as easily get double the value we now receive for many farm crops.

THE COMPOST HEAP.

Composting manure is not usually economical where general farming is done. It requires too much labor; besides, the manure will ordinarily give better results when scattered directly on the ground

[1] Hutchinson, W. L. Exhaustion and Restoration of Soil Fertility. Bulletin 29, Mississippi Agricultural Experiment Station.

and plowed or harrowed in. It is advised only where coarse materials need to be put in better condition. It is also advisable for truckers and gardeners.

By the compost heap the farmer is able to multiply his available manure manyfold. He should remember that anything of vegetable or animal origin is a valuable fertilizer if put in proper condition. The compost heap is one means of doing this. One ton of leaves contains 15 pounds of nitrogen, 3.2 pounds of phosphoric acid, and 6 pounds of potash, and at ordinary values for these substances is worth nearly $3.46. Straw and sawdust similarly are worth about $3 each per ton. These values of course are based on their total composition. In actual practice it is safe to assume that half of their values are available; but it is only after undergoing decomposition that these values are available.

HOW TO MAKE A COMPOST HEAP.

Locate the compost heap in an old shed, or build a shed, with any kind of cheap material for a roof. Spread on the ground a layer of stable manure 8 by 10 feet, 6 inches deep. Over this spread 100 pounds of acid phosphate or ground phosphate rock. The phosphate rock answers as well as the acid phosphate and costs about half as much. Continue these alternate layers until the manure is used up or until the pile has become inconveniently high. To these layers might be added straw, leaves, mold, or other litter, adding 100 pounds ground phosphate rock to each ton of material used. Be sure to wet all thoroughly. When the compost heap is completed, cover it about 4 inches deep with good loam or with forest mold.

HOW TO APPLY THE COMPOST.

When applying 2 tons per acre or less, the best results can be obtained by putting the compost in the furrow and bedding out on it. Be careful not to bury too deep, especially on clay soils. When using more than 2 tons per acre it is better to scatter broadcast.

Bearing in mind the supplemental value of the cowpea, it is safe to say that by using compost at least 50 per cent can be added to the productiveness of the average 100-acre farm, and that simply at the cost of a few tons of acid phosphate and a little labor. With the barnyard manure and with the cowpea at his service to save and gather nitrogen for him, the average farmer is simply wasting his money when he continues to buy nitrogen in commercial fertilizer when he could easily produce all that his land needs upon his farm. Economy should be his watchword, and there is no better place for him to start than by stopping the waste of nitrogen that is so flagrant throughout the whole South.

GREEN MANURES.

It has been found beneficial to plow under green crops on depleted soils or soils deficient in humus. Among the best crops for this purpose may be named cowpeas, velvet beans, clover, buckwheat, and sorghum. Ordinarily the crops should be allowed to reach maturity before turning under. It is not a good practice to turn under a heavy green crop immediately before planting another crop, especially small grain.

A cover crop is usually sown late in the season, after the main crop is out of the way. Oats, rye, and crimson clover are most commonly used for this purpose. They are sown in the cotton or corn at the time of the last working and make some growth during the autumn and early spring. They serve the double purpose of adding humus and of preventing soil erosion. The cover crop should be plowed under at least two weeks before the time for planting the next crop. Green-manure crops are helpful in improving the mechanical condition and rendering available the plant food already in the soil.

It is hoped that the value of farm manures has been made sufficiently evident and that more farmers will give attention to the saving of them.

COMMERCIAL FERTILIZERS.

Since the prime object in the use of all commercial fertilizers is to increase production, they must be used either to supply plant food directly or to act upon the soil so that a larger quantity of its nutritive elements will be at the disposal of the plant. In actual practice most commercial fertilizers combine both effects. All the substances required by plants except three--nitrogen, phosphoric acid, and potash—are abundant in most soils.

HOW TO BUY FERTILIZER.

Commercial plant food called "fertilizer" is not obtainable except in combination with other substances. The substances with which it is combined are of no value to the farmer. The value of any fertilizer does not depend on its gross weight, but on its percentage of available plant food. The laws of nearly all the States now require that on each sack of commercial fertilizer shall be stamped just what plant food it contains. This composition is given in percentages, which means that in a hundred pounds of the fertilizer there are so many pounds of the particular substances.

For example, a certain fertilizer is offered for sale on the sack of which is branded the following:

Nitrogen	2 per cent.
Water-soluble phosphoric acid	8 per cent.
Citrate-soluble phosphoric acid	2 per cent.
Total available phosphoric acid	10 per cent.
Potash	2 per cent.

Translated into terms of pounds this means that in a sack weighing 100 pounds there are—

2 pounds of nitrogen.
8 pounds of water-soluble phosphoric acid.
2 pounds of citrate-soluble phosphoric acid.
10 pounds of available phosphoric acid.
2 pounds of potash.

This gives a total of 14 pounds of plant food in a 100-pound sack. When a ton of such fertilizer is bought, the purchaser receives nitrogen, 40 pounds; water-soluble phosphoric acid, 160 pounds; citrate-soluble phosphoric acid, 40 pounds; and potash, 40 pounds. Notice that what is called "available" is the sum of the water-soluble and the citrate-soluble acid. In this fertilizer we obtain three things that are of use—2 pounds of nitrogen, 10 pounds of phosphoric acid, and 2 pounds of potash to the 100 pounds.

If cottonseed meal, acid phosphate, and kainit are used to make this fertilizer, it will require the following quantities for 1 ton of the mixture:

TABLE IV.—*Proportions and value of cottonseed meal, acid phosphate, and kainit required for a ton of fertilizer of given composition.*

Fertilizing material.	Pounds.	Value.
Cottonseed meal (6.4 per cent nitrogen)	625	$8.00
Acid phosphate (16 per cent available)	1,140	10.00
Kainit (12.5 per cent potash)	235	2.00
Total	2,000	20.00

The above figures express the actual cost of the materials, so by the time such a fertilizer reaches the farmer it will cost him nearer $25 per ton. The difference between the value of materials and the price the farmer pays represents the cost of mixing and bagging and the profits.

It will be found that all materials used in mixing fertilizers vary in the amount of plant food contained in them. Taking acid phosphate as an example, we find some running as low as 10 pounds of available phosphoric acid per 100 pounds, while the best grade runs as high as 16 pounds or more per 100 pounds. On this basis, valuing phosphoric acid at 5 cents per pound, the first would cost 50 cents whereas the latter would cost 80 cents. Even greater differences will be found in the grades of cottonseed meal.

Samples can now be found ranging from 3.5 per cent to 7 per cent of nitrogen. Basing the values on the nitrogen contained, Table V shows the relative values of cottonseed meal of the different grades. It is assumed that cottonseed meal containing 6.5 per cent of nitrogen can be bought for $28 per ton.

TABLE V.—*Values per ton of cottonseed meal of different grades.*

Per cent of nitrogen.	Value.	Per cent of nitrogen.	Value.	Per cent of nitrogen.	Value.	Per cent of nitrogen.	Value.
6.5	$28.00	6.3	$27.13	6.0	$25.84	5.1	$21.97
6.4	27.67	6.2	26.71	5.6	24.12	3.5	15.07

The average sample of cottonseed meal contains approximately the following percentages of plant food.

Nitrogen..... 6.4 per cent.
Phosphoric acid..... 2.7 per cent.
Potash..... 1.8 per cent.

A 100-pound sack will therefore contain the following quantities of plant food:

Nitrogen..... 6.4 pounds.
Phosphoric acid..... 2.7 pounds.
Potash..... 1.8 pounds.

The results following the use of cottonseed meal indicate that decomposition makes the phosphoric acid in the meal available. In buying materials for mixing fertilizers it is always economy to use only high-grade goods, even though they cost a little more.

HOW TO USE COMMERCIAL FERTILIZERS.

If fertilizers are used, the following general rule should govern: On rich lands use mainly fertilizers that will stimulate the fruit and not the stalk growth. On lighter lands use more of the elements to force growth, combined with others which will mature the fruit. High-grade acid phosphate may be considered a basis for increasing the fruit and hastening the maturity of crops. Even on the richest land it has been demonstrated that a small percentage of nitrogen added to the acid phosphate gives better results.

As has been stated, the cheapest and best way to fertilize is with barnyard manure, vegetable matter, and the growing of the legume crops.

NITROGEN.

The chief function of nitrogen in plants is to promote growth, but it is also of very great importance in the production of fruit. Nitrogen enters largely into the composition of plants, and it follows that everything of vegetable origin is a valuable source of this substance. When vegetable matter is burned the nitrogen is released from its combination, escapes into the atmosphere, and is lost. Hence, it is bad practice to burn off fields and destroy vegetable matter; it is better to turn it under. The humus in vegetable matter has a value in soil renovation frequently greater than its value as a plant food. The most important sources of nitrogen used in commercial fertilizers are as follows:

TABLE VI.—*Nitrogen content of important fertilizer materials.*

Source of nitrogen.	Per cent.	Source of nitrogen.	Per cent.
Cottonseed meal	6 to 7	Fish scrap	7 to 8
Dried blood	12 to 14	Sulphate of ammonia	18 to 20
Tankage	9 to 12	Nitrate of soda	14 to 16

PHOSPHORIC ACID.

Next in importance as a plant food is phosphoric acid. It is largely required by the plant for growth, but it is absolutely essential in promoting fruitage and is a great factor in hastening the maturity of the crops. The principal commercial sources of phosphoric acid are as follows:

TABLE VII.—*Phosphoric acid content of important fertilizer materials.*

Source of phosphoric acid.	Per cent.	Source of phosphoric acid.	Per cent.
Rock phosphate:		Bone meal:	
Dissolved	12 to 16	Dissolved	15 to 17
Ground	24 to 32	Ground	20 to 22
Thomas slag	15 to 20		

POTASH.

Potash is more directly effective in developing the fruit and adds to the vigor of the plants. It is seldom deficient in soils and especially in the soils of the Gulf States. It is obtained from the following sources:

TABLE VIII.—*Potash content of important fertilizer materials.*

Source of potash.	Per cent.	Source of potash.	Per cent.
Kainit	12.5	Sulphate of potash	53
Muriate of potash	50.0	Wood ashes	5 to 20

It should be understood that all the fertilizing contents of the above-named materials are not readily available for the use of the plant. The amounts available should always determine the value of the material. An example to illustrate may be found in acid phosphate. The total content of the ground rock is twice that of dissolved rock, but such a large per cent of the ground rock is unavailable that it might be cheaper to buy the dissolved rock at twice the price per ton. The same principle applies in greater or less degree to all the other materials used in making commercial fertilizers.

WHAT FERTILIZER TO BUY.

Since the elements of plant food already mentioned are required in different quantities by different plants and since the soils vary in their supply, it is well for the farmer to know what his soil and plants need before investing his money in fertilizers. The practical way for the

farmer to determine these facts is to observe the growth of the plants on his land. If the plants grow rapidly and make an abundance of leaf and stalk it is evidence of a good supply of nitrogen. If there is not a proportionate amount of fruit it is a sure indication that the soil needs phosphoric acid. On the other hand, if the plant does not have a good color and tends to drop its fruit before it reaches a fair size it indicates that the soil requires potash.

Most of the soils in the South are deficient in both nitrogen and phosphoric acid, and some in potash. So, when commercial fertilizers are bought their value depends upon their content of these substances. If the farmer has saved all manures and has grown cowpeas or other legumes abundantly, he will rarely have to buy nitrogen.

For rich soils, or soils where a heavy crop of peas, beans, or clover was grown the previous year, use 1 part of cottonseed meal and 3 parts of acid phosphate for cotton. For medium soils use 1 part of cottonseed meal and 2 parts of acid phosphate. On thin soils use 1 part of cottonseed meal and 1 part of acid phosphate. These proportions are for soils rich in potash, but deficient in nitrogen and phosphoric acid. Experiments have shown that most of the soils in the Gulf States do not need potash for growing field crops. On soils showing a need of it potash should be added. On some soils experiments have shown that neither acid phosphate nor potash is needed; examples of such soils are found in the black waxy lands of west Alabama and east Mississippi and Texas and the stiff alluvial lands of the Mississippi Valley. On these soils nitrogen and humus seem to be all that is needed. Deep sandy lands such as are found in Florida and along the coastal plains are in many cases deficient in potash, as well as in phosphoric acid and in nitrogen. On such soils a complete fertilizer should be used.

AMOUNT OF FERTILIZER TO USE PER ACRE.

No definite instructions in regard to the use of fertilizers can be given to fit all conditions and soils. This question must be settled by tests on individual farms. The following formulæ will serve as a guide in mixing fertilizers to be used under the conditions mentioned:

TABLE IX.—*Proportions of fertilizers for cotton.*

Fertilizer to be used.	Pounds of fertilizer per acre.			
	On sandy loam or clay soils, when—			On deep sandy soil of medium grade.
	Poor.	Medium.	Rich.	
Cottonseed meal	150	100	75	150
Acid phosphate	150	200	225	150
Kainit	.....	.....	.....	150

Where it is found that potash is needed on clay lands, 50 pounds of kainit or its equivalent in muriate or sulphate of potash may be added.

Where the land has grown a heavy crop of peas or beans the year before, half the amount of cottonseed meal may be used.

On the black waxy soils of Alabama and Mississippi and the stiff alluvial lands of the Mississippi Valley that have been planted to cotton for a long period of years and have become deficient in vegetable matter, 200 to 300 pounds of cottonseed meal per acre have given profitable returns.

The formulæ suggested for cotton should be slightly changed for corn, making the amounts of cottonseed meal and acid phosphate more nearly equal.

The amount of fertilizer to use depends on several factors. The cost of the material used in the fertilizer, the value of the land, the need and condition of the soil, and the money value of the crops to be grown must each be considered. The greater the money value the crop represents the larger the quantity of fertilizer that can be used with profit. On soils thoroughly prepared and cultivated, fertilizers will give greater profits. Large applications of fertilizer never pay on thin, poorly prepared soils. It is a question of economics as well as of crop culture. With 14-cent cotton the farmer can realize large returns from 600 to 800 pounds per acre on soils in good condition. It seldom pays to use large quantities of commercial fertilizer for corn. We should depend mainly on cowpeas, clover, and barnyard manures.

TABLE X.—*Proportions of fertilizers for small grains, potatoes, and legumes.*

Fertilizer to be used.	Pounds of fertilizer per acre.					
	For oats or wheat on medium soils.				For potatoes.	For legumes.
	No. 1.	No. 2.	No. 3.	No. 4.		
Stable manure	10,000					
Acid phosphate (14 per cent)	200	200		250	350	225
Cottonseed meal		200	150		350	75
Bone meal			200			
Nitrate of soda				100		
Muriate or sulphate of potash					50	

When nitrate of soda is used it should be applied as a top-dressing in spring, when the straw begins to joint. The acid phosphate should be applied broadcast at planting time.

When either formula 2 or 3 is used it should be applied broadcast at planting time. When stable manure is used it may be disked in at the time of planting, except in semiarid sections.

When potash is required it may be added to the mixtures for small grains in the proportion heretofore recommended for cotton.

The formula for potatoes included in Table X may be considered a sample fertilizer for sweet and Irish potatoes on land which will produce half a bale of cotton per acre. Potash is included for use on soils which require it, and as the potato uses relatively more potash than other crops the amount in this mixture is made correspondingly high.

Cowpeas and soy beans usually obtain enough nitrogen from the air and soil to make a satisfactory growth, but it has been found that a small per cent of nitrogen mixed with the fertilizer will greatly aid the young plants in starting off freely.

It has also been found very satisfactory to apply the acid phosphate intended for the following year's crop under the peas or beans grown the summer before. This will increase the vine and root growth enough to give abundant nitrogen for the next crop, and by a small application of acid phosphate and potash in the spring the land will produce excellent crops of corn, cotton, or small grain.

The mixture "For legumes" in Table X is recommended for either peas, beans, or peanuts. The suggestions in reference to the use of potash apply here as before.

TABLE XI.—*Proportions of fertilizers for sugar cane and for pastures.*

Fertilizer to be used.	Pounds of fertilizer per acre.		
	For plant cane.	For stubble cane.	For pastures.
Acid phosphate	600	400	300
Cottonseed meal	400	600	....
Lime	.....	.....	1,000 to 2,000
Nitrate of soda	.....	.....	100 to 150

Owing to the heavy crops produced, sugar cane necessarily makes heavy drafts on the soil, especially of nitrogen and phosphoric acid. The Louisiana Agricultural Experiment Station, after years of special experimenting with the crop, found that an application of 24 to 48 pounds of nitrogen and 30 to 36 pounds of phosphoric acid was necessary to produce good crops and keep up the fertility of the soil. These experiments were made on rich alluvial lands. On lands less fertile heavier applications may be found necessary. If potash is required in the soil, add 50 pounds of sulphate or muriate of potash.

The most economical method of establishing grass for meadow or pasture in any part of the South is to make a thorough summer preparation of the land following a crop of small grain, and then to apply 1,000 to 2,000 pounds of lime and mix well with soil by using a section harrow. Apply 300 pounds of acid phosphate per acre at

the time of seeding. The following spring apply 100 to 150 pounds of nitrate of soda.

DIFFERENT FORMS OF FERTILIZING MATERIALS.

Elsewhere in this circular are suggested some of the most common sources of nitrogen, phosphoric acid, and potash. In the formulæ given acid phosphate and cottonseed meal have been used. They are the most commonly known and more generally used. If for any good reason it is desirable to substitute other materials in the mixtures, it can readily be done. Simply substitute in proper proportions. Ordinarily nitrate of soda should not be used in making mixed fertilizers. It is better to use it as a top-dressing for growing crops.

METHODS OF MIXING.

The mixing of fertilizers on the farm can be done very satisfactorily by emptying the raw materials on a tight floor of wood or concrete; or if more convenient it may be done on a hard dirt floor under a shed or outhouse.

It is better not to empty over 400 to 600 pounds at one time, as it can be more readily and thoroughly mixed in small quantities. The mixing can be done with hoes and shovels by turning over two or three times and continuing this process until the desired quantity is ready for use. This method of home mixing is very desirable where the farmer wishes to leave out any element or in any way change the proportion to better suit special conditions.

HOW TO APPLY COMMERCIAL FERTILIZERS.

Before applying commercial fertilizers prepare the soil thoroughly. Where 500 pounds of fertilizer or less is used for cotton put it all out in one application in the furrow about 10 days before planting and mix well with the soil. Where 600 or more pounds per acre are used two applications should be made, one-half in the furrow before planting and the remainder as side applications at the first or second working of the crop. When using 1,000 pounds or more, make two or more applications or broadcast the entire amount before planting.

Where more than 200 pounds of fertilizer is used for corn on thin soil two applications are recommended, 200 pounds in the furrow before planting and the remainder as a side application when the corn is about a foot high. On medium or rich soils all the fertilizer may be applied around the corn.

The depth to which the commercial fertilizer is applied is important. Experiments have shown that 3 inches is about the proper depth in all except semiarid sections, where it should be put deeper. It has been a common practice among farmers to apply fertilizers too deep.

LIMING SOILS.

Nearly all soils contain enough lime for plant growth, but experiments have shown that it is beneficial in rendering the plant food in the soil more available, and also that it greatly improves the mechanical condition of many soils. It renders a stiff clay soil more porous, while on light, leachy soils it has the opposite effect. It is also valuable in sweetening certain soils that have become sour. One to four thousand pounds per acre of lime may be used. Apply lime in the fall or early spring. When the application is made to grass land, the lime should be spread 10 days before seeding. An application once in four or five years has been found sufficient. Lime should be applied broadcast and mixed with soil by the use of a disk or section harrow.

W. B. Mercier,
Assistant and Agriculturist.
H. E. Savely,
Assistant and Agriculturist.

Approved:
B. T. Galloway,
Chief of Bureau.

June 17, 1911.

○